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MAGNETIC CONCENTRATION OF QUARTZ SAND FOR GLASS INDUSTRY

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The authors consider the production experience of a separator of the new generation with constant magnets based on Nd – Fe – B, which was designed by ÉMKO Company for producing quartz glass concentrates of grades OVS-030 and OVS-025, using dry magnetic separation. The proposed separator has several advantages compared to electromagnetic separators of the EVS series, which have the same purpose.

One of the main quality criteria of batch materials used in glass melting is the content of iron oxides, which are pigment impurities affecting the clarity of glass. Therefore, the content of iron oxides in glass of various grades is strictly regulated. Thus, the permissible Fe_2O_3 content in household glass is no more than 0.050% (here and elsewhere mass content is indicated), in clear glass 0.012 – 0.020%, crystal glass 0.025 – 0.035%, and light engineering and medical glass not more than 0.070%. The content of Fe_2O_3 in sheet glass is permitted within the limits of 0.09 – 0.20%. The admissible content of ferric oxide in container glass is relatively high: not more than 0.1% in clear glass BT-1 and not more than 0.8% in green glass ZT-1 and brown glass KT-1 [1].

The listed restrictions concerning the iron oxide content in finished glass determines the requirements imposed on the upper limit of their content in traditional glass batch materials (quartz glass, dolomite, soda, chalk, pegmatite, etc.) and nontraditional materials such as blast slag used in production of dark container glass.

The purity of ceramic materials used is also important for glass factories which have divisions making molding equipment based on refractory ceramics to be used in production of glass. A content of Fe_2O_3 in ceramic materials above the admissible levels results in the formation of iron "smelting" in refractory articles and, consequently, their rejection.

Batch materials for glass and ceramic production with a required (permissible) content of iron-bearing impurities are produced using various concentration methods, including the methods of dry and wet magnetic separation.

In the last few years, the ÉMKO Company has developed and implemented a number of magnetic concentration plants for materials used in glass and ceramic production: a plant for purifying crushed recycled Bakor material from iron-bearing impurities and inclusions at the Shcherbinskii Eletromelted Refractory Works; glaze concentration at the Lobnenskii Construction Porcelain Factory and at Samarskii Stroifarfor JSC; dry concentration of blast furnace slag at Chagodoshchenskii Steklozavod & K; concentration of alumina materials for production of refractories at Medsteklo JSC (Klin); concentration of chalk and dolomite at Khrustalny Zavod JSC (Gus-Khrustalny).

The theoretical principles of concentration of materials using the magnetic separation method, comparative descriptions of various types of magnetic separators, and the recommended equipment for magnetic concentration and purification of glass and ceramics materials from magnetic impurities are presented in [2 – 4].

The present paper considers the industrial use experience of a magnetic separator of the new generation based on permanent magnets, intended for dry concentration of quartz sand, at Ramenskii Mining-Concentration Works.

Ramenskii Mining-Concentration Works is the leading producer of high-quality quartz concentrate in the Russian Federation. The sands from the Eganovskoe and Chulkovskoe deposits supplied to Ramenskii Mining-Concentration Works contain 0.05 – 0.30% iron oxides. To produce quartz concentrate used in the glass industry, sands with an initial Fe_2O_3 content equal to 0.050 – 0.075% are selected.

At the first stage of quartz concentrate production, wet concentration methods are used: washing of argillaceous

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Fig. 1. LMO-10000 plant for dry magnetic concentration of quartz sand.

components, attrition, and de-sliming. Depending on the initial Fe_2O_3 content, the concentrate obtained after wet concentration corresponds to grade VS-050 or OVS-030 (GOST 22551–77) with the ferric oxide content below 0.050 and below 0.030%, respectively.

Additional concentration of sand preliminarily subjected to wet concentration and drying is implemented using the method of dry magnetic separation, making it possible to obtain quartz concentrates of grades OVS-030, OVS-025, and OVS-020 with a ferric oxide content less than 0.030, 0.025, and 0.020%, respectively.

Ramenskii Mining-Concentration Works uses an 2ÉVS 36/100 electromagnetic separator for dry magnetic concentration. Separators of the ÉVS series are currently the main traditional concentration plants used to produce high-quality quartz concentrates at domestic enterprises for mining and processing of quartz sand and glass factories making high-quality glass. For instance, the electromagnetic separator 2ÉVS 36/100 with rated output up to 10 ton/h weighs around 8 tons and consumes 30 kW of electricity. The cost of ÉVS separators is substantial as well.

After the concentration of sand with initial Fe_2O_3 contents 0.040 – 0.035 and 0.035 – 0.030 on a 2ÉVS 36/100 electromagnetic separator, the resulting concentrates have grades OVS-030 and OVS-025, respectively. It should be noted that the actual output of the separator 2ÉVS 36/100 for the specified concentration efficiency is 6 – 7 ton/h, as distinct from the rated output 10 ton/h (GOST 10512–93).

In 1999 Ramenskii Mining-Concentration Works commissioned specialists from EMCO company to develop an industrial separator based on constant magnets with output 10 ton/h, in order to produce concentrated quartz sand of grades OVS-030 and OVS-025 from sand with an initial ferric oxide content 0.030 – 0.040%.

The ÉMKO Company has its own production facilities producing various constant magnets based on Nd – Fe – B, which are currently the most powerful, some of them having unique geometrical shapes. For the last five years the company has been developing and manufacturing magnetic separators based on constant magnets for various industrial sectors. The company was able in a short time to develop a highly efficient industrial separator of the new generation producing high-quality quartz concentrate, and by a number of parameters, this separator significantly surpasses the ÉVS electromagnetic separators.

The LMO-10000 industrial plant for quartz sand concentration (magnetic concentration line with output 10,000 kg/h) is shown in Fig. 1. The design of the dry magnetic concentration plant LMO-10000 is based on the drum principle. The plant consists of two identical modules, each of capacity 5 ton/h. Each module has two drums 164 mm in diameter with a 600 mm long magneto-active zone, the drums rotating towards each other. The magnetic system placed inside the drum develops a magnetic field of 700 mT on the drum surface with a magnetic field gradient about 1000 mT/cm.

The operating principle of drum-type magnetic separators is as follows. The sand containing magnetic impurities arrives on the drum. Magnetic impurity particles are attracted to the surface of the drum, which rotates around the immobile magnetic system, and move together with the drum towards the discharge zone where the “attracting” effect of the magnetic system stops. The “non-magnetic” material fraction (concentrated sand) leaves the drum earlier and by a different route under the effect of the centrifugal force and gravity. It is possible to vary the degree of sand concentration by means of a special adjustable gate which separates pure (concentrated) material and magnetic impurities (tails).

The operating efficiency of the plant LMO-10000 is 10 ton/h for dry sand of the fraction 0.8 mm. The plant is installed in the same production area as the 2ÉVS 36/100 magnetic separator, and concentrated sand from both magnetic separators is transferred to the same conveyor.

The results of the periodic chemical analysis of sand concentrated on the LMO-10000 plant and analyzed in the chemical laboratory of Ramenskii Mining-Concentration Works demonstrate reliable production of sand of grade OVS-25 from initial sand with 0.030 – 0.035% Fe_2O_3 and sand of grade OVS-030 from initial sand with 0.035 – 0.040% Fe_2O_3.

With equal effectiveness of magnetic concentration, the LMO-10000 plant on constant magnets designed by ÉMKO has 1.5 times greater output and consumes 4 kW electric power (this is the power of four reduction motors used to rotate the magnetic drums), and its weight is one-tenth of the weight of the 2ÉVS 36/100 electromagnetic separator. An important factor in the present economic conditions is the fact that the LMO-10000 plant costs half as much as the 2ÉVS 36/100 separator.

The LMO-10000 plant for quartz sand concentration has been continuously operated at the Ramenskii Mining-Concentration Works for more than half a year, and its operation caused no complaints.

At the moment, the specialists of ÉMKO Company are working in order to further improve the efficiency of new-generation magnetic separators on constant magnets based on Nd – Fe – B intended for profound concentration of quartz sand and other materials in which the magnetic fraction is represented by weekly magnetic (mainly paramagnetic) impurities.,

Thus, the magnetic separators on constant magnets based on Nd – Fe – B designed by the EMCO company in terms of the equal concentration effect and equal output substantially surpass the electromagnet separators of the ÉVS series with respect to energy consumption, weight, size, and cost.

Magnetic separators on constant magnets have been successfully implemented in production and can be recommended for industrial use at glass factories and mining-concentration works producing concentrated quartz sand.

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